Headquarters U.S. Air Force

Integrity - Service - Excellence

FORMER WILLIAMS AIR FORCE BASE

BCT MEETING

23 April 2015

Headquarters U.S. Air Force

Integrity - Service - Excellence

SITE ST012,
FORMER LIQUID FUELS STORAGE AREA

REMEDIAL ACTION

ST012 UPDATE

- Steam Enhanced Extraction (SEE) Operations Progress
- Near-term SEE Operational Plan
- Soil Vapor Extraction (SVE) System Update

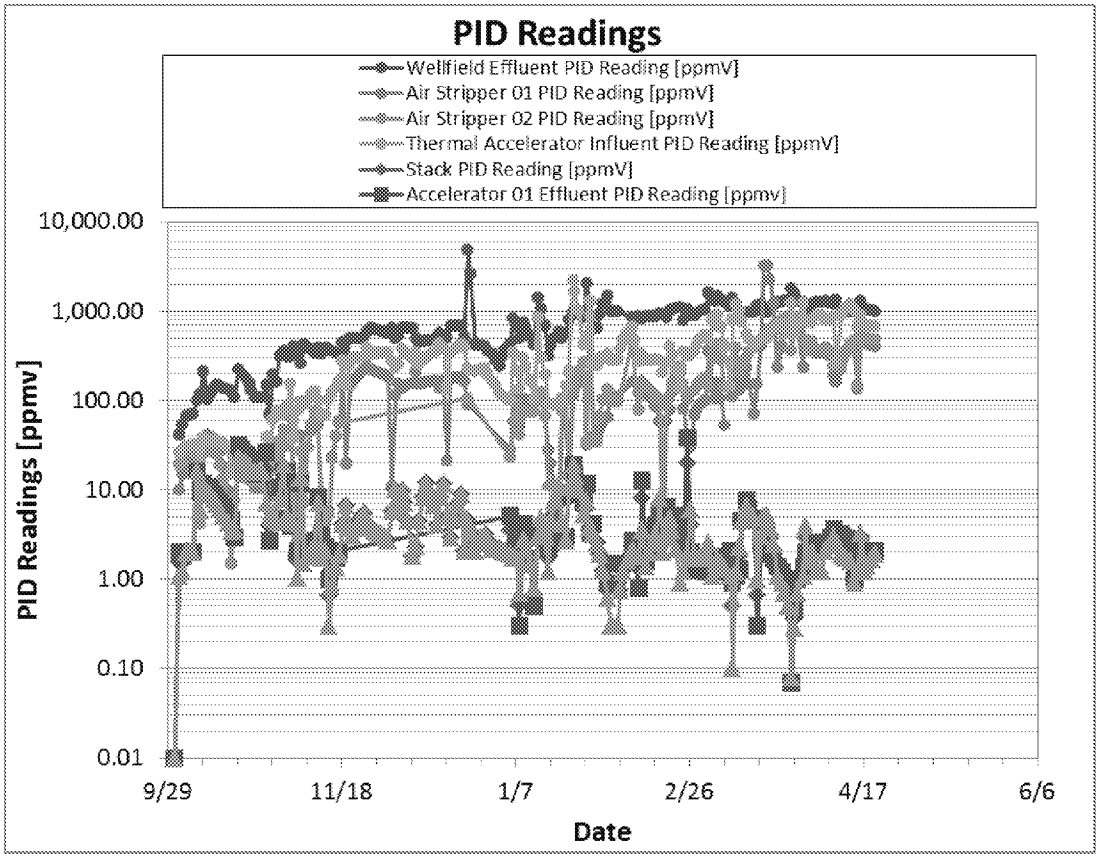
SEE System Updates

ST012 SEE SYSTEM STATUS - SUMMARY

	Value	Unit	
Target Treatment Zone (TTZ) Soil Volume	410,000	cubic yards (cy)	
Area	199,000	square feet (ft^2)	
Upper Depth of Treatment	145	feet (ft) below ground surface (bgs)	
Lower Depth of Treatment	245	ft bgs	
Vapor Liquid Treatment Started	09/29/14		
Thermal Operations Started	09/29/14		
Last Process Data Update	04/20/15		
Last Temperature Data Update	04/20/15		
Estimated Total Days of Operation	422	days	
Days of Operation	203	days	
Days of Operation vs. Estimate	48	percent (%)	
Estimated Total Energy Usage	11,343,000	kilowatt hours (kWh)	
Total Energy Used	1,704,983	kWh	
Used Electrical Energy vs. Estimate	15	%	
Total Steam Injected	109.1	million pounds (lbs)	
Projected Total Steam Injection	320	million lbs	
Steam Injected Vs Projected	34	%	
Total Mass Removed in Vapor Based on Photoionization Detector (PID) Readings	179,387	lbs	
Total Mass Removed as NAPL	431,889	lbs	
Total Vapor and Liquid Mass Removal (based on PID readings)	611,276	lbs	
Average Power Usage Rate Last Week	303	kilowatts (kW)	
Average Wellfield Vapor Extraction Rate Last Week	332	standard cubic feet per minute (scfm)	
Average Condensate Production Rate Last Week	0.1	gallons per minute (gpm)	
Average Water Extraction Rate Last Week	116	gpm	*
Total Water Extracted	30,001,115	gallons	
Total Recovered Light Non-Aqueous Phase Liquid	65,637	gallons	
Average Water Discharge Rate Last Week	156	gpm	
Total Treated Water Discharge	37,435,000	gallons	

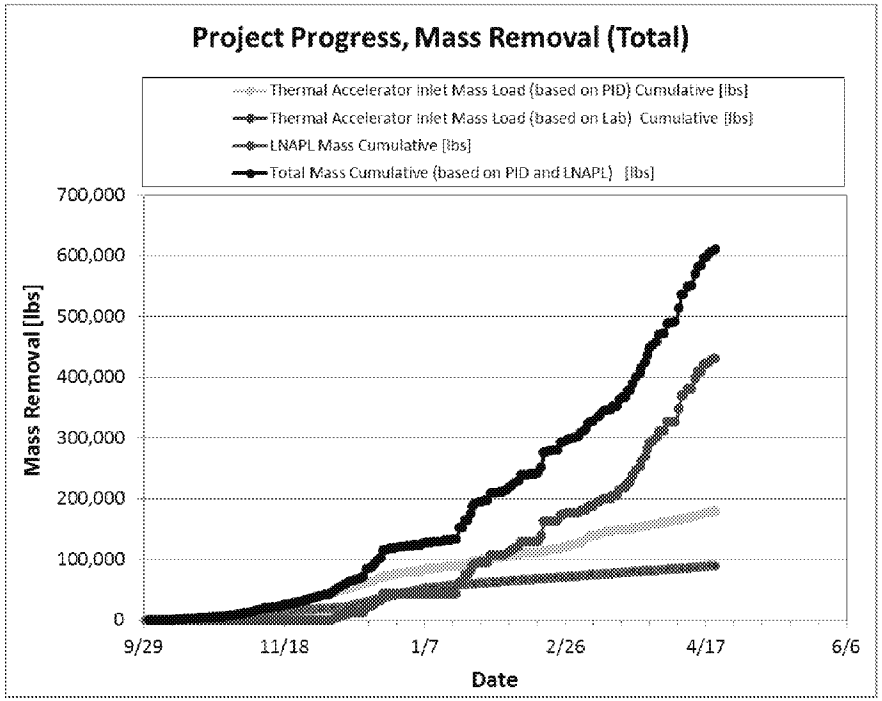
***Typical operating rate was 130 gpm. Average rate is lower due to system downtime for biomat treatment in sediment tanks**

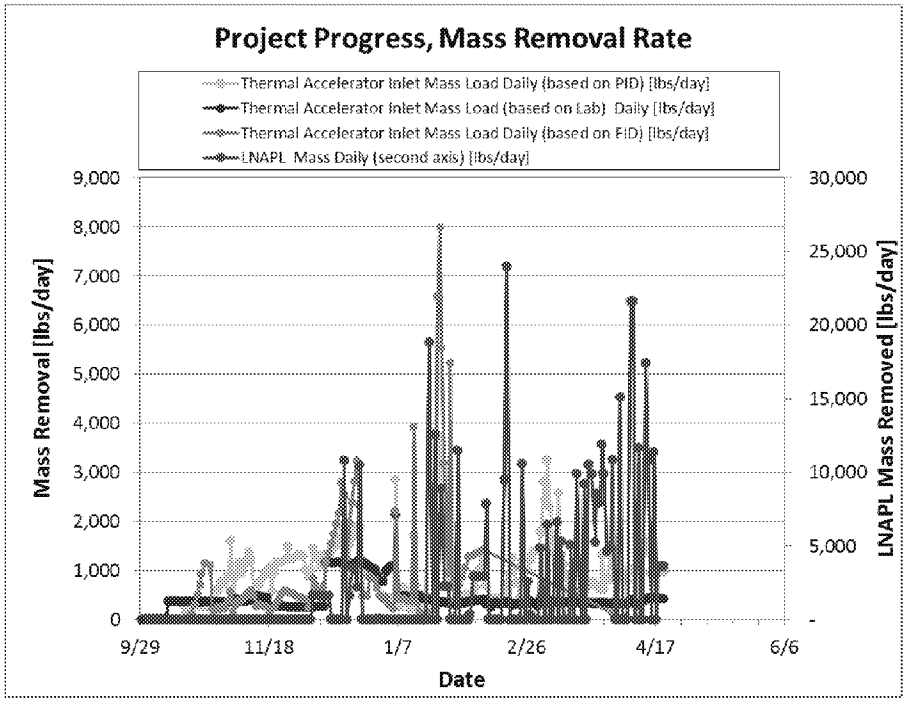
ST012 SEE SYSTEM PHOTO IONIZATION DETECTOR (PID) READINGS



- Vapors continue to be rich in organics

ST012 SEE SYSTEM MASS REMOVAL





- Non-aqueous phase liquid (NAPL) recovery continues
- An estimated 432,000 lbs (~66,000 gallons) of mass has been removed as NAPL
- An estimated 179,000 lbs of mass (PID) has been removed in the vapor phase

ST012 Steam Injection Status

ST012 SEE OPERATIONAL PROGRESS

- **SEE Startup** — 29 Sep
- **Extraction Only Phase** — 29 Sep – 15 Oct
  - All Cobble Zone (CZ), Upper Water Bearing Zone (UWBZ), and Lower Saturated Zone (LSZ) Multiphase Extraction (MPE) wells turned on
  - Extraction System Optimization/Troubleshooting
  - Perimeter Monitoring to Demonstrate Hydraulic Control
- **Steam Injection Step 1** — 16 Oct – 3 Nov
  - 9 Exterior LSZ wells
  - Perimeter and Temperature Monitoring for Effects
- **Steam Injection Step 2** — 3 Nov – 4 Dec
  - Same 9 Exterior LSZ wells from Step 1
  - Add 6 Interior LSZ wells
  - Perimeter and Temperature Monitoring for Effects
- **Steam Injection Step 3 – revised** — 4 Dec – 22 Dec
  - Same 15 LSZ wells from Step 2
  - Add 7 Exterior UWBZ wells
  - Perimeter and Temperature Monitoring for Effects

ST012 SEE OPERATIONAL PROGRESS - CONTINUED

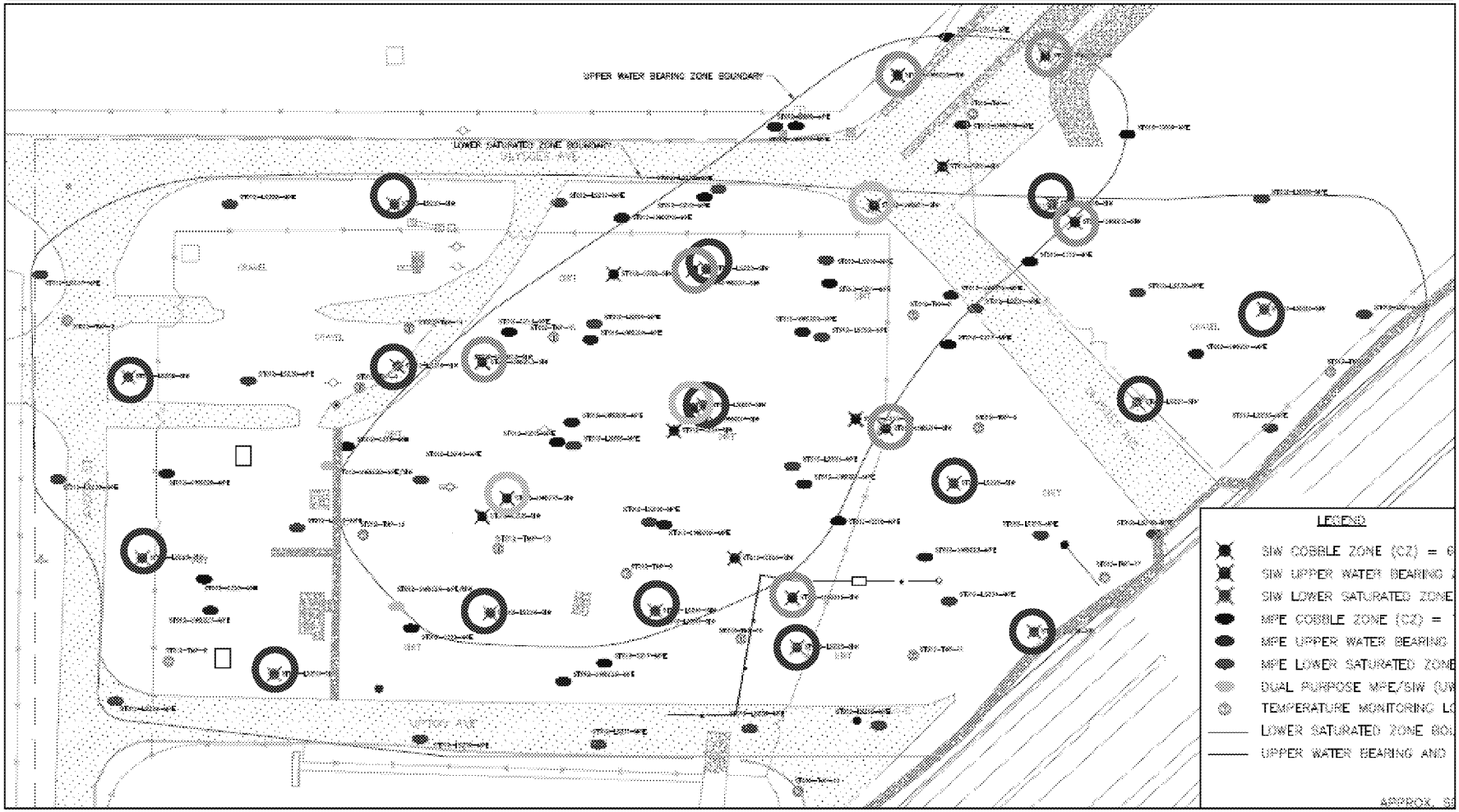
- **Liquid Treatment System Cleanouts/ Changeouts** — **23 Dec – 5 Jan**
  - Accumulated biomass cleaned out of process tanks
  - Liquid carbon vessel changeout

- **SEE System Operations** — **6 Jan – 23 Feb**
  - Average liquid extraction rate of 86 gallons per minute (gpm)
  - From 6 January through 19 January typically three eductor skids were online at a time
  - From 20 January to present, typically four eductor skids were online at a time – beginning 18 February, eductor skid 6 (primarily servicing the down gradient edge of the treatment zone) has been operated continuously
  - Average steam injection rates of 18,700 lbs per hour in the LSZ and 4,900 lbs per hour in the UWBZ
  - Twenty-one steam wells are currently online – injection rates at wells have varied due to boiler issues and in preparation for MPE transition piece preventative replacement
  - On 16 February injection well LSZ26 was shut down in preparation for the MPE transition piece preventative replacement in nearby wells

ST012 SEE OPERATIONAL PROGRESS - CONTINUED

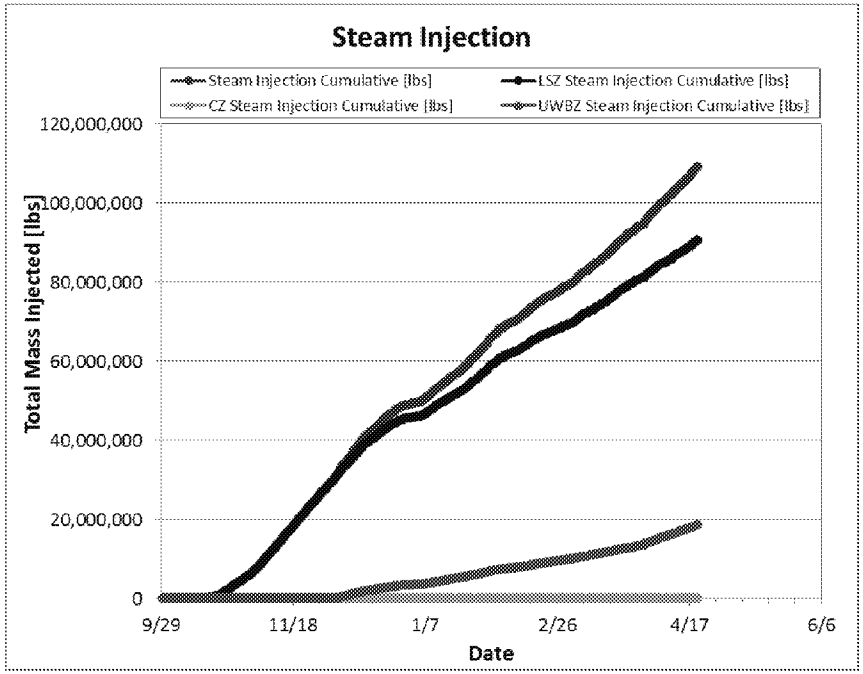
- **SEE System Operations** — **24 Feb – 23 Mar**
  - Average liquid extraction rate of 86 gpm
  - Typically four eductor skids were online at a time – eductor skid 6 (primarily servicing the down gradient edge of the treatment zone) has been operated continuously
  - Average steam injection rates of 15,600 lbs per hour in the LSZ and 4,900 lbs per hour in the UWBZ
  - Twenty-one steam wells are currently online – injection rates at wells have varied due to boiler issues and due to MPE transition piece preventative replacement
- **SEE System Operations** — **23 Mar – Present**
  - Average liquid extraction rate of 126 gpm
  - Typically five eductor skids were online at a time – eductor skids 4 and 6 have been operated continuously
  - Average steam injection rates of 18,100 lbs per hour in the LSZ and 8,800 lbs per hour in the UWBZ
  - Twenty-five steam wells are currently online (see next slide) – injection rates at wells have varied due to boiler issues

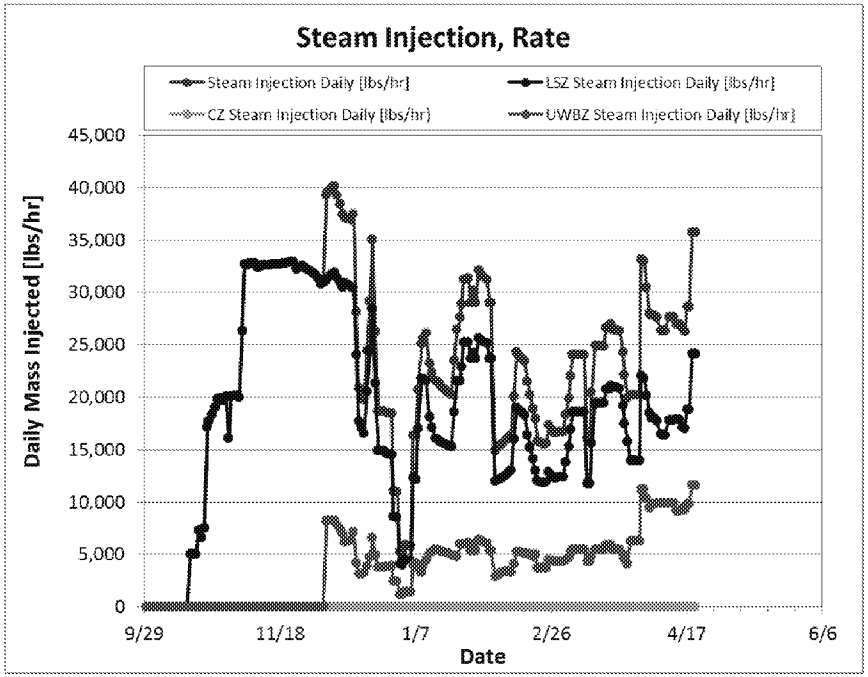
ST012 STEAM INJECTION – MODIFIED STEP 3 PERIMETER UWBZ



LSZ wells online (15) UWBZ wells online (7) UWBZ wells brought online (3)

ST012 SEE STEAM INJECTION





- **Current average steam injection:**
  - UWBZ 11,600 lbs/hr ~ 23 gpm as water
  - LSZ 24,200 lbs/hr ~ 48 gpm as water total

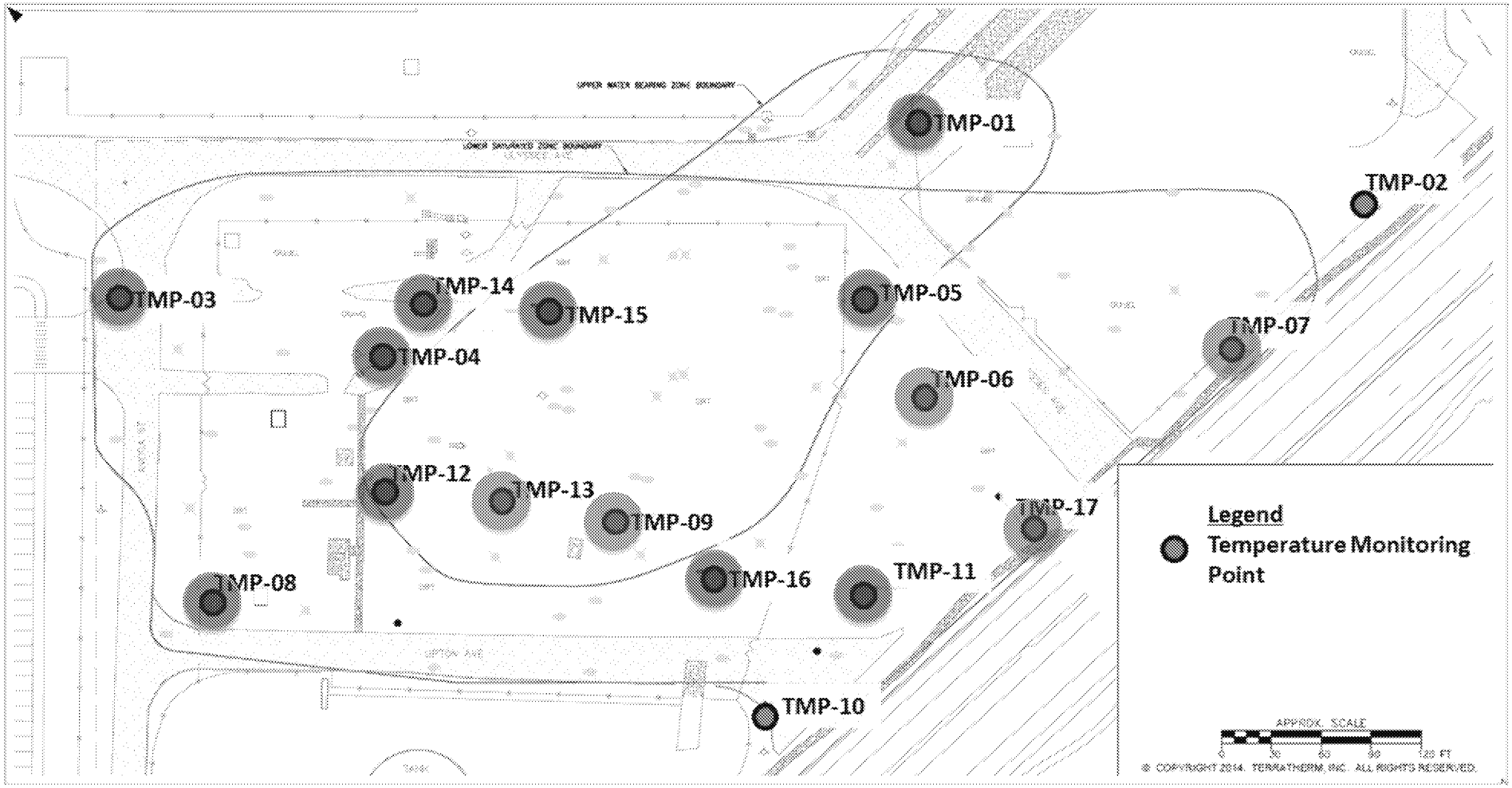
- **Total steam injection rate equivalent to 71 gpm of water**

ST012 SEE DISCHARGE COMPLIANCE

- Coordination was conducted with the City of Mesa throughout January and February 2015 and the City did not identified any additional actions or concerns.
- We continue to collect weekly samples of carbon influent, midfluent, and effluent to monitor for breakthrough. In addition, midfluent is sampled twice per week for pesticides.
- We continue to operate both air strippers, manage biomass layers in the T102 tank that feeds the air strippers and GAC, and monitor closely for breakthrough at the GAC midfluent.

ST012 Steam Injection Influence at Temperature Monitoring Points

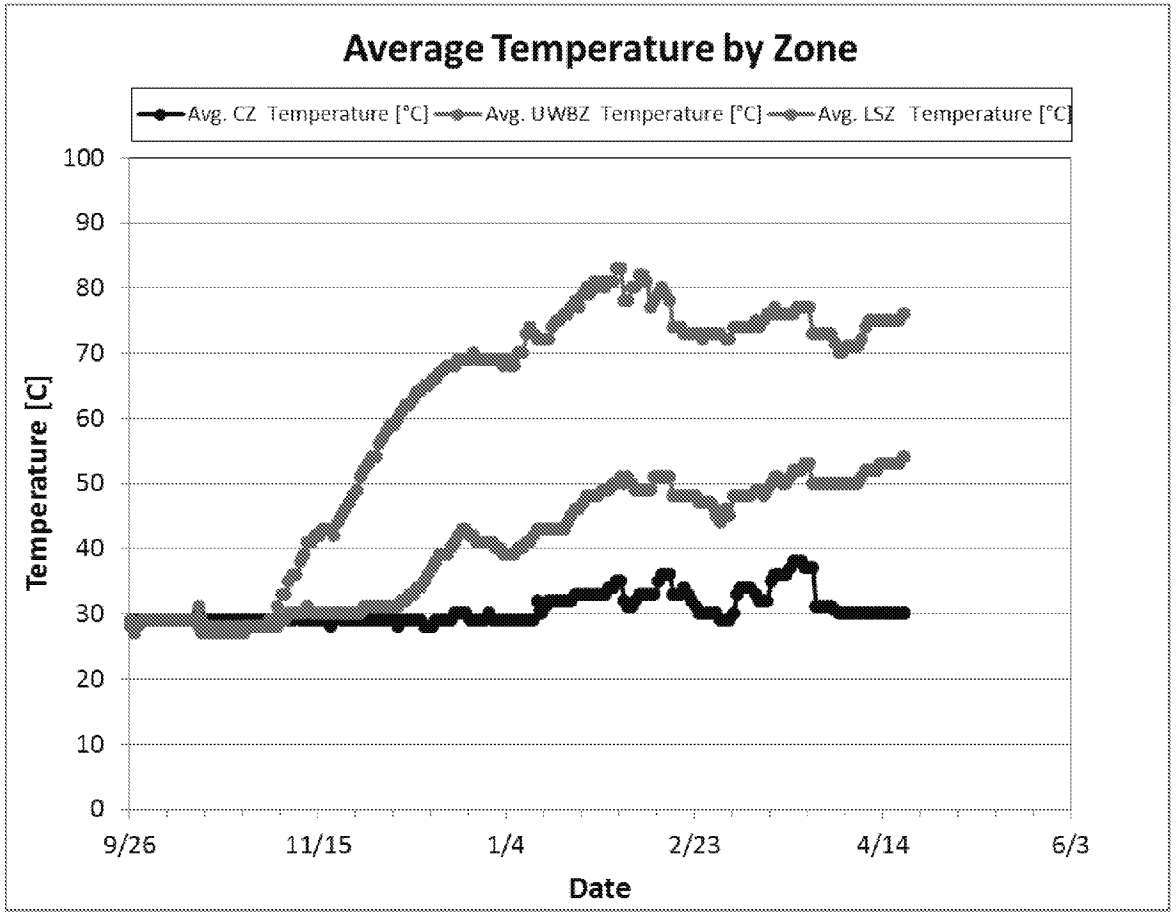
ST012 TEMPERATURE MONITORING POINTS

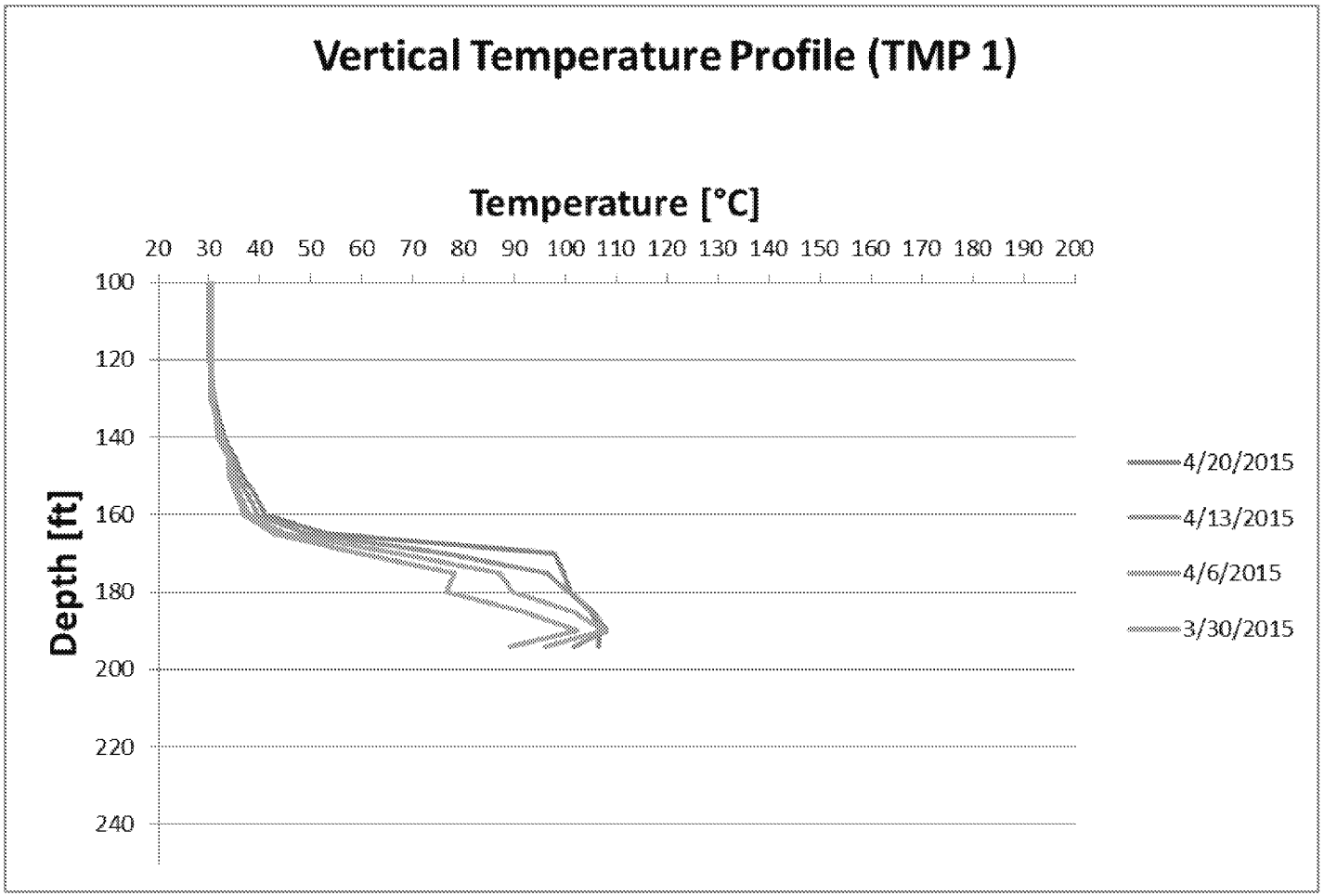


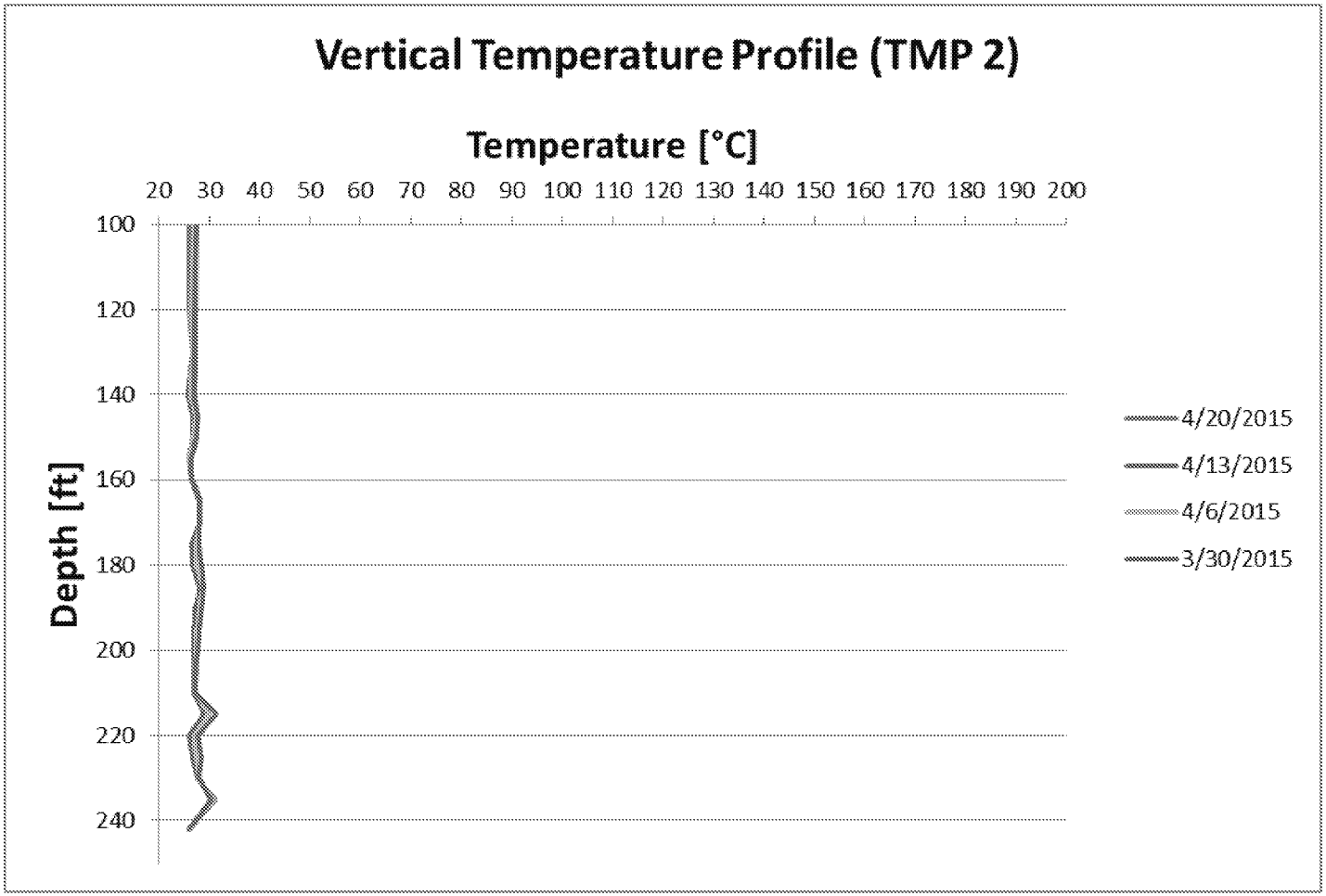
TMPs show heat up

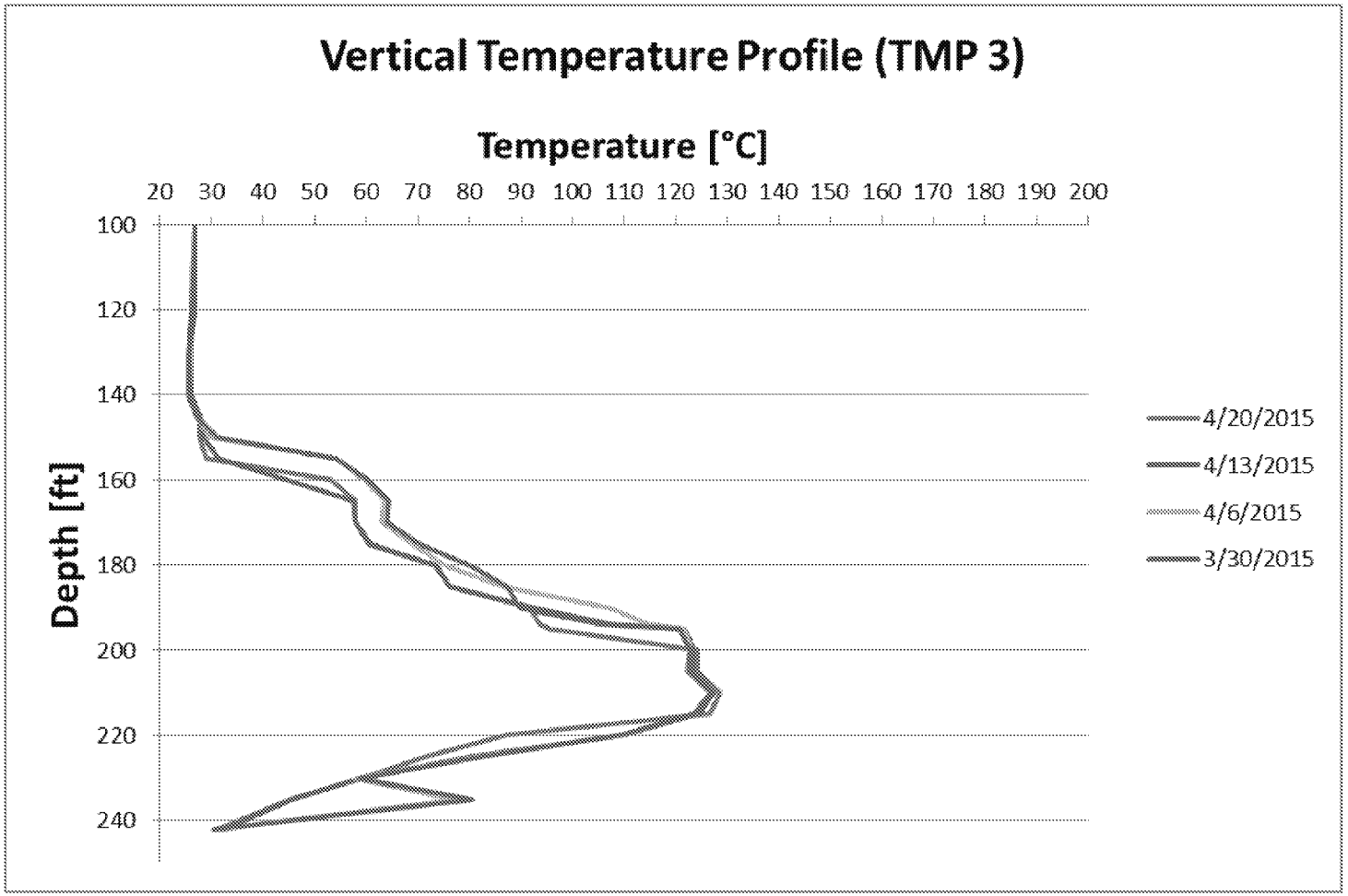
TMPs requiring repair

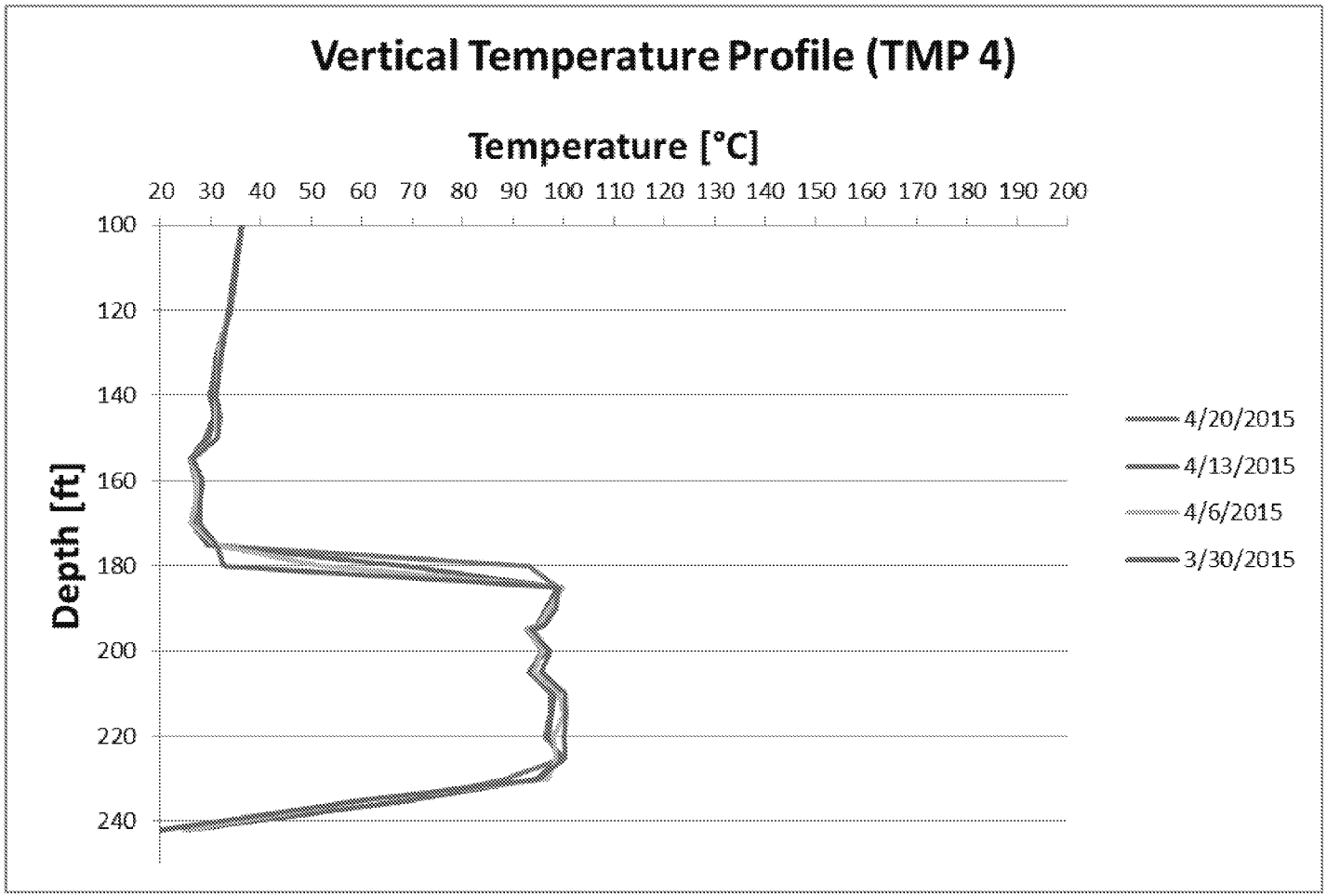
ST012 SEE COLLOCATED TEMPERATURES AT EXTRACTION WELLS BY ZONE

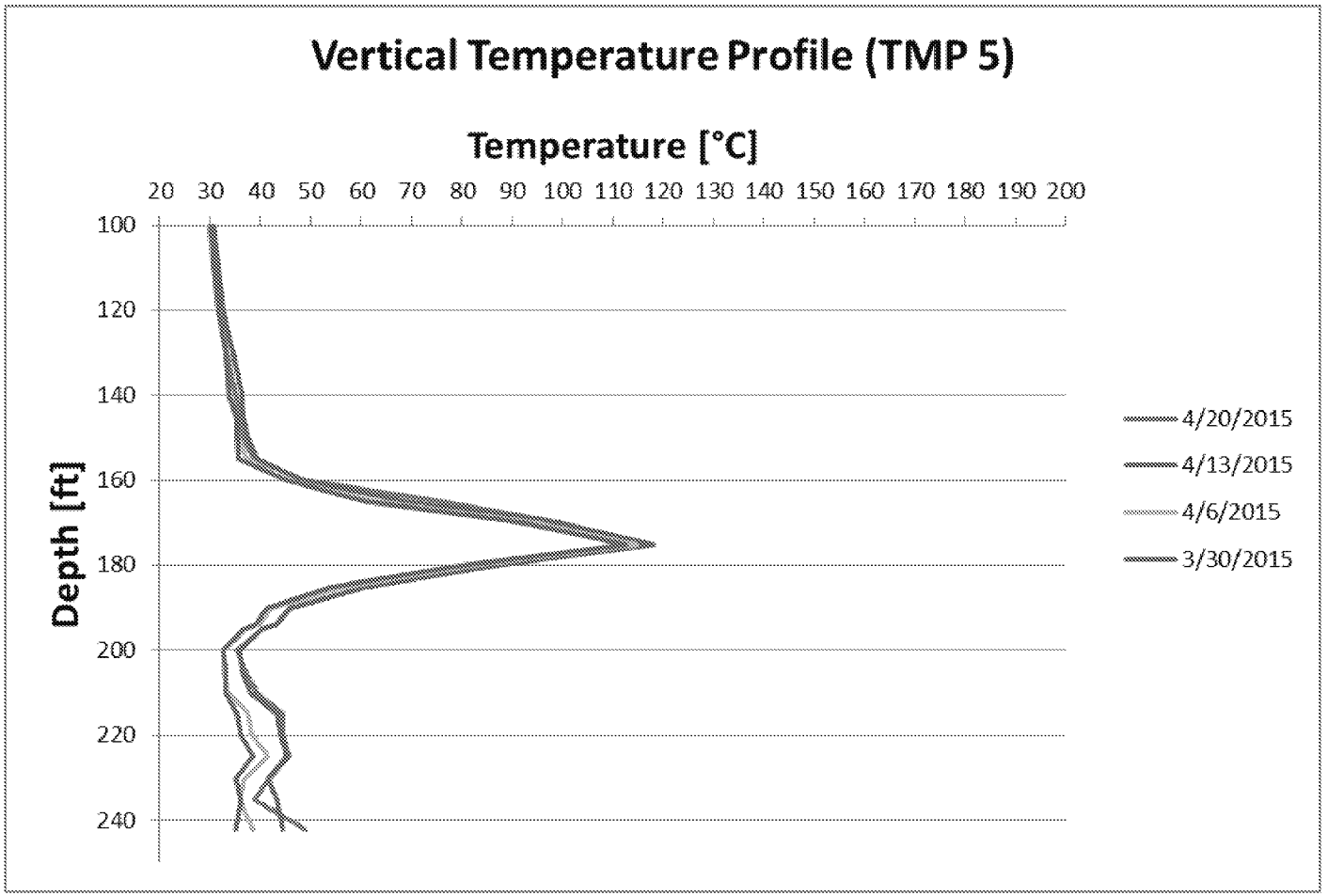


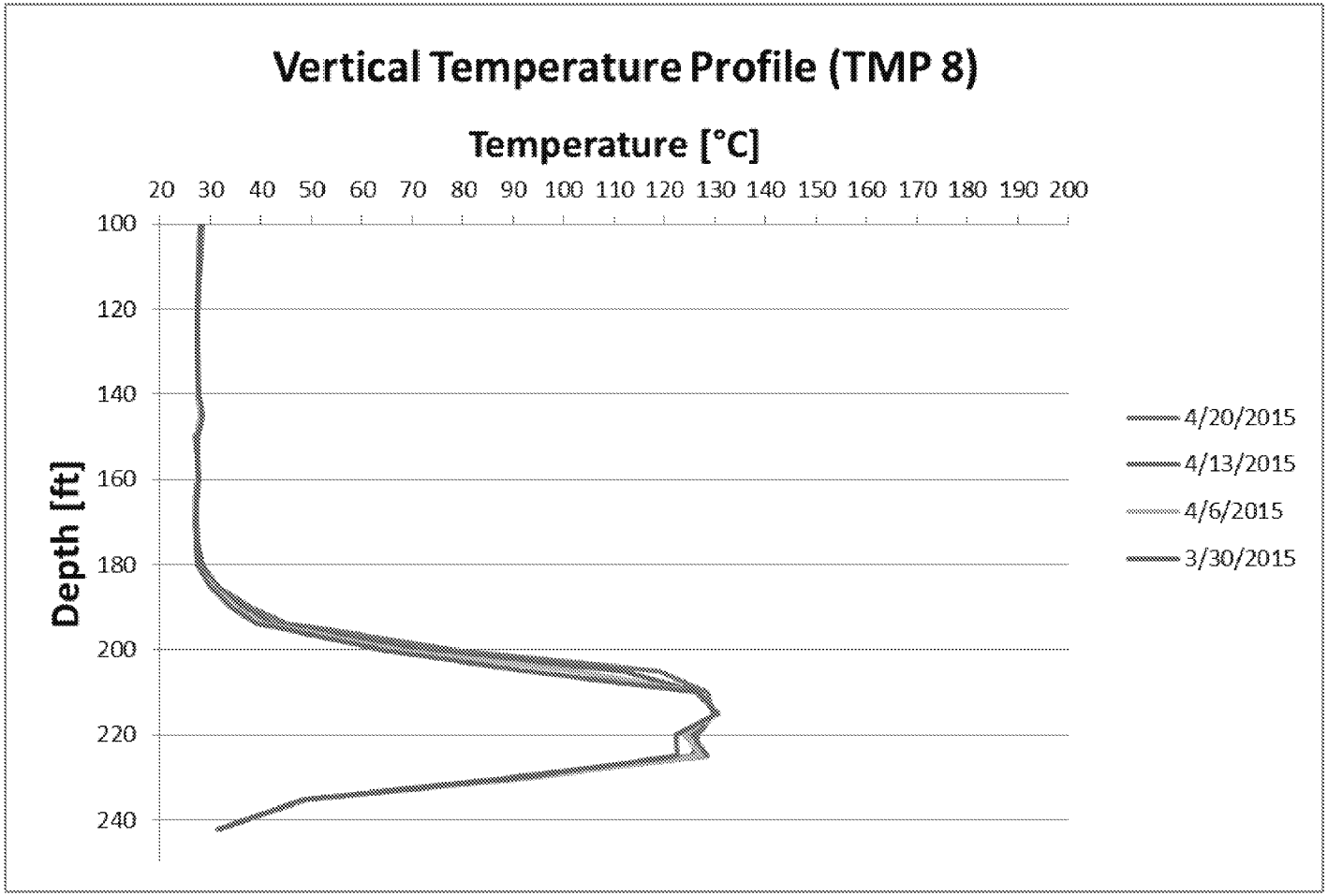


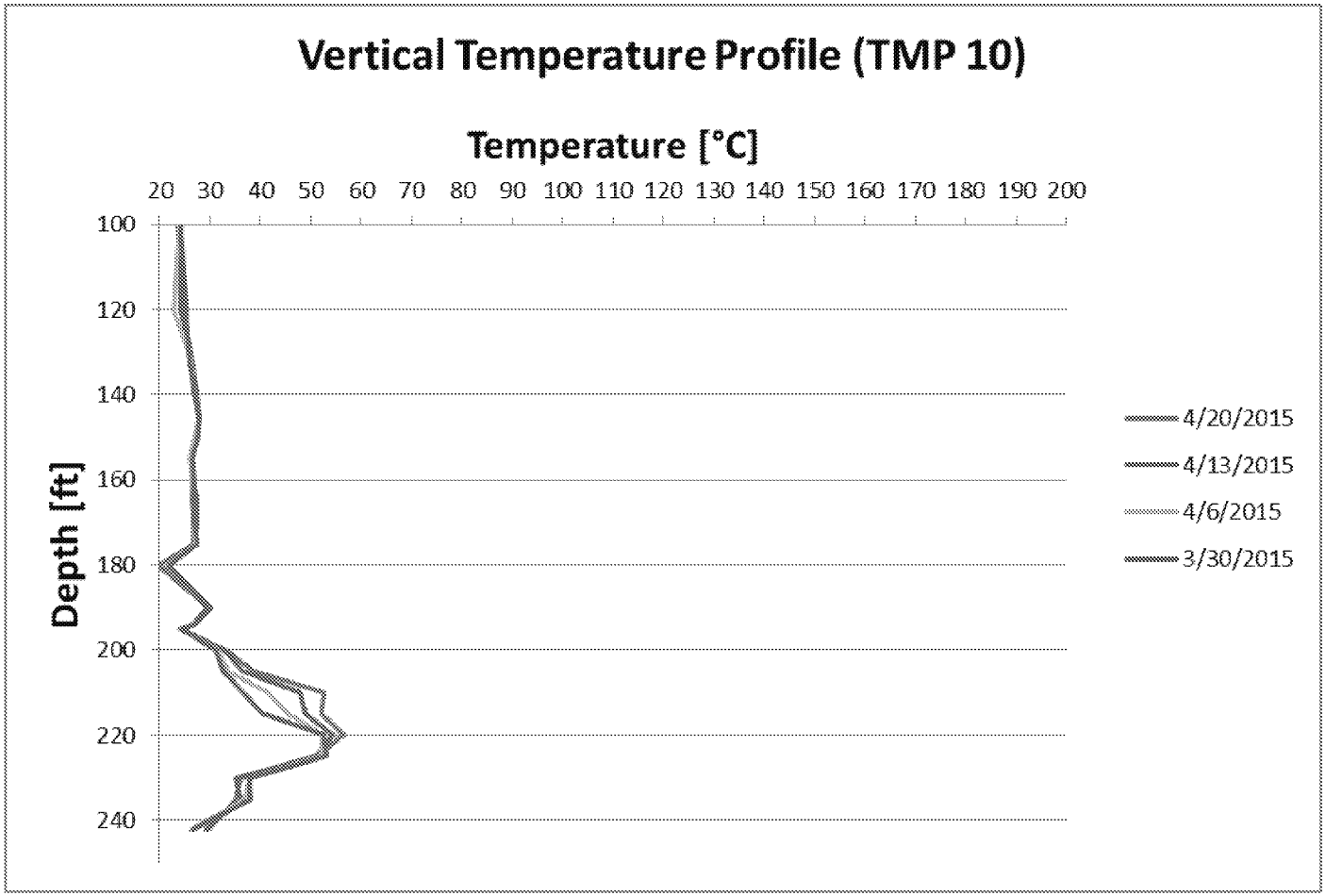


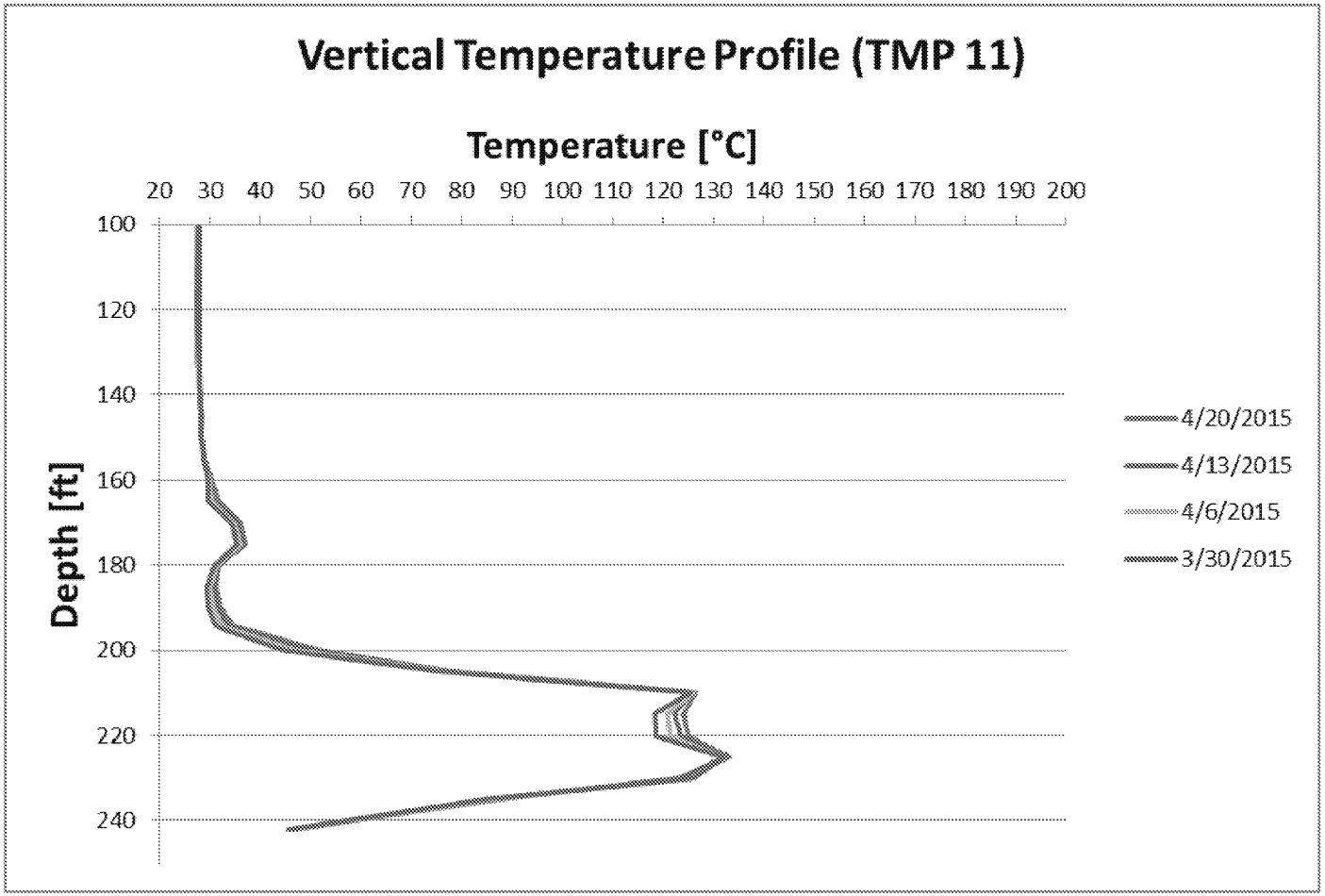


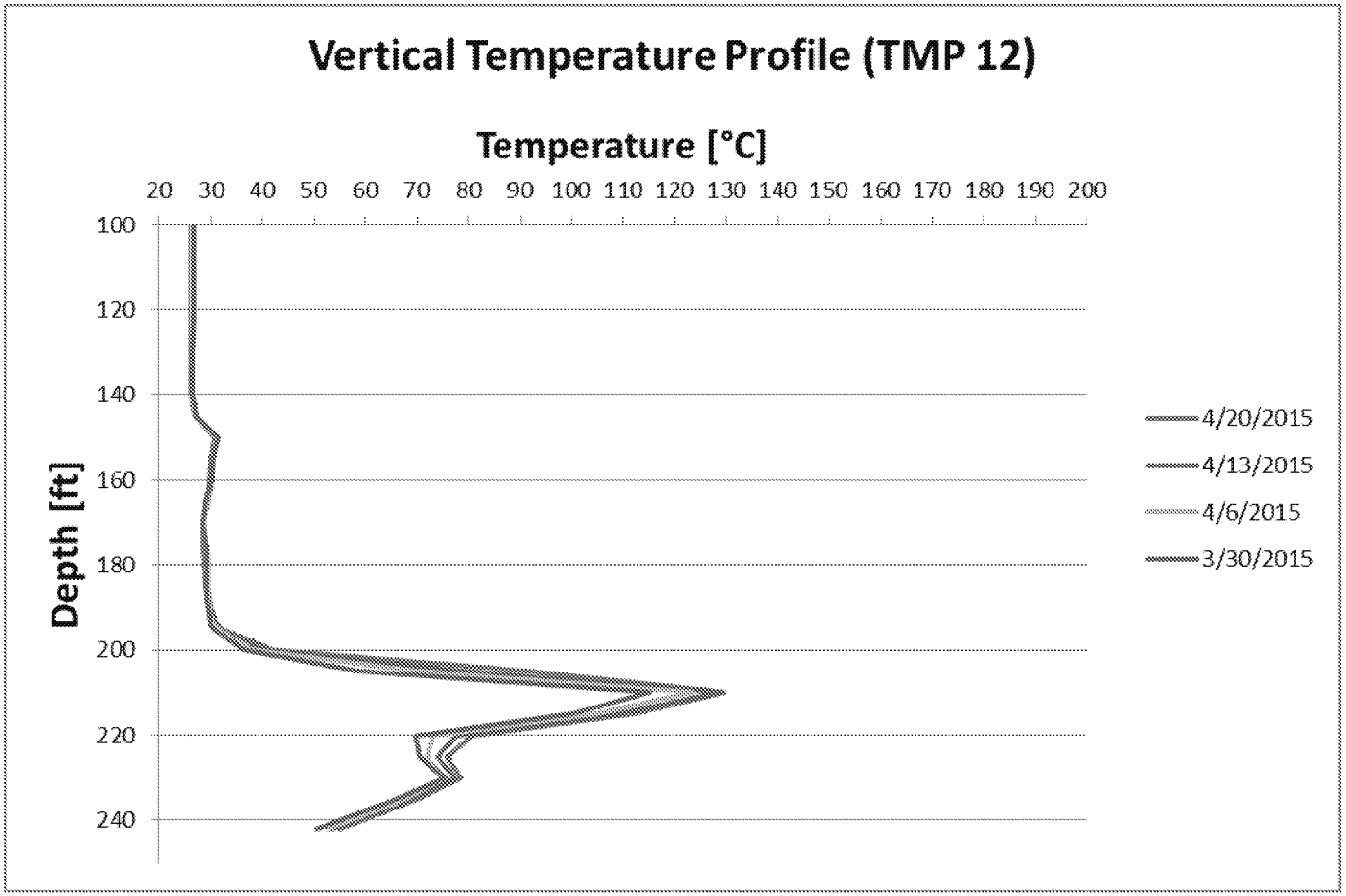


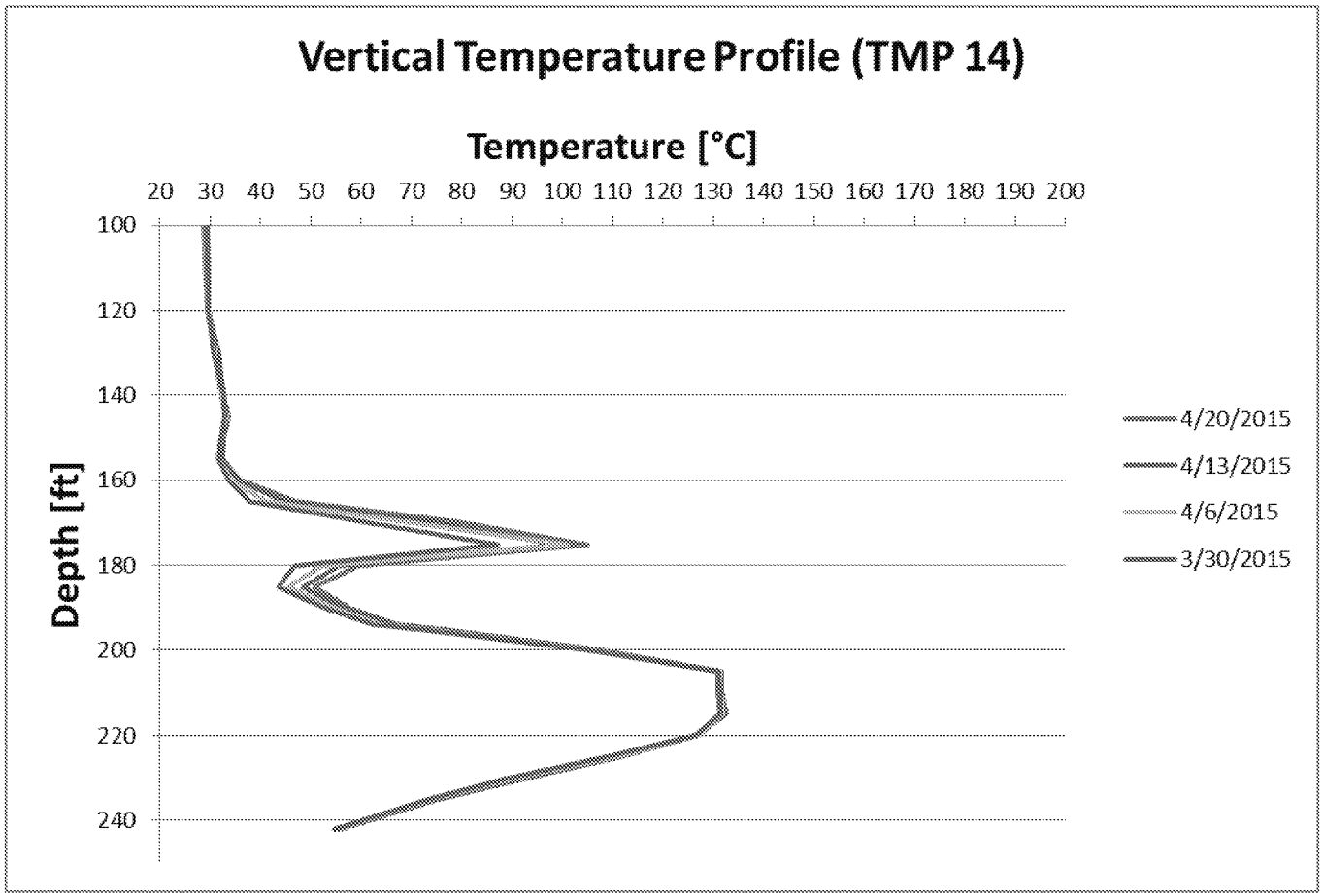

Vertical Temperature Profile (TMP 5)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100
120
140
160
180
200
220
240
4/20/2015
4/13/2015
4/6/2015
3/30/2015

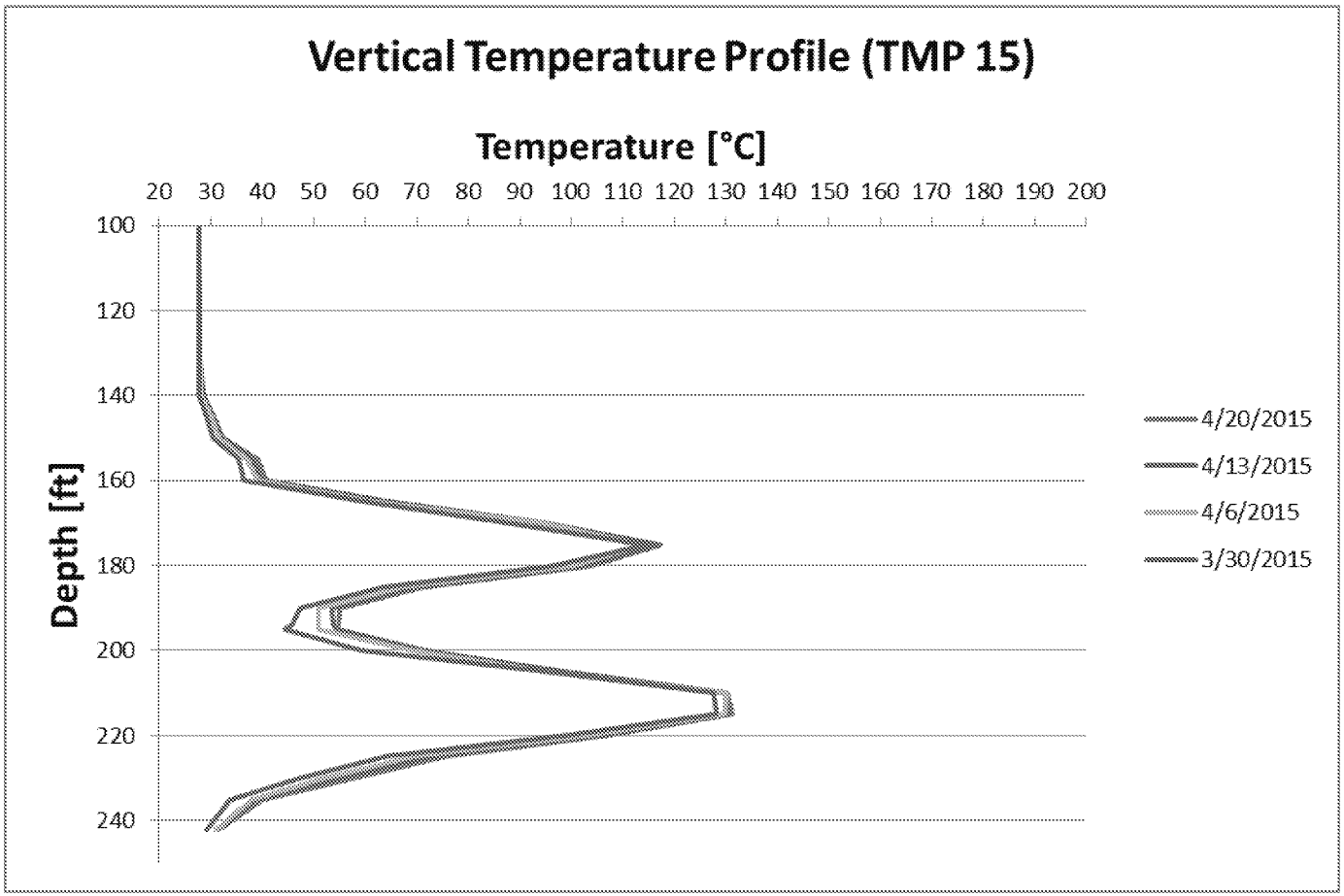

Vertical Temperature Profile (TMP 8)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100
120
140
160
180
200
220
240
4/20/2015
4/13/2015
4/6/2015
3/30/2015

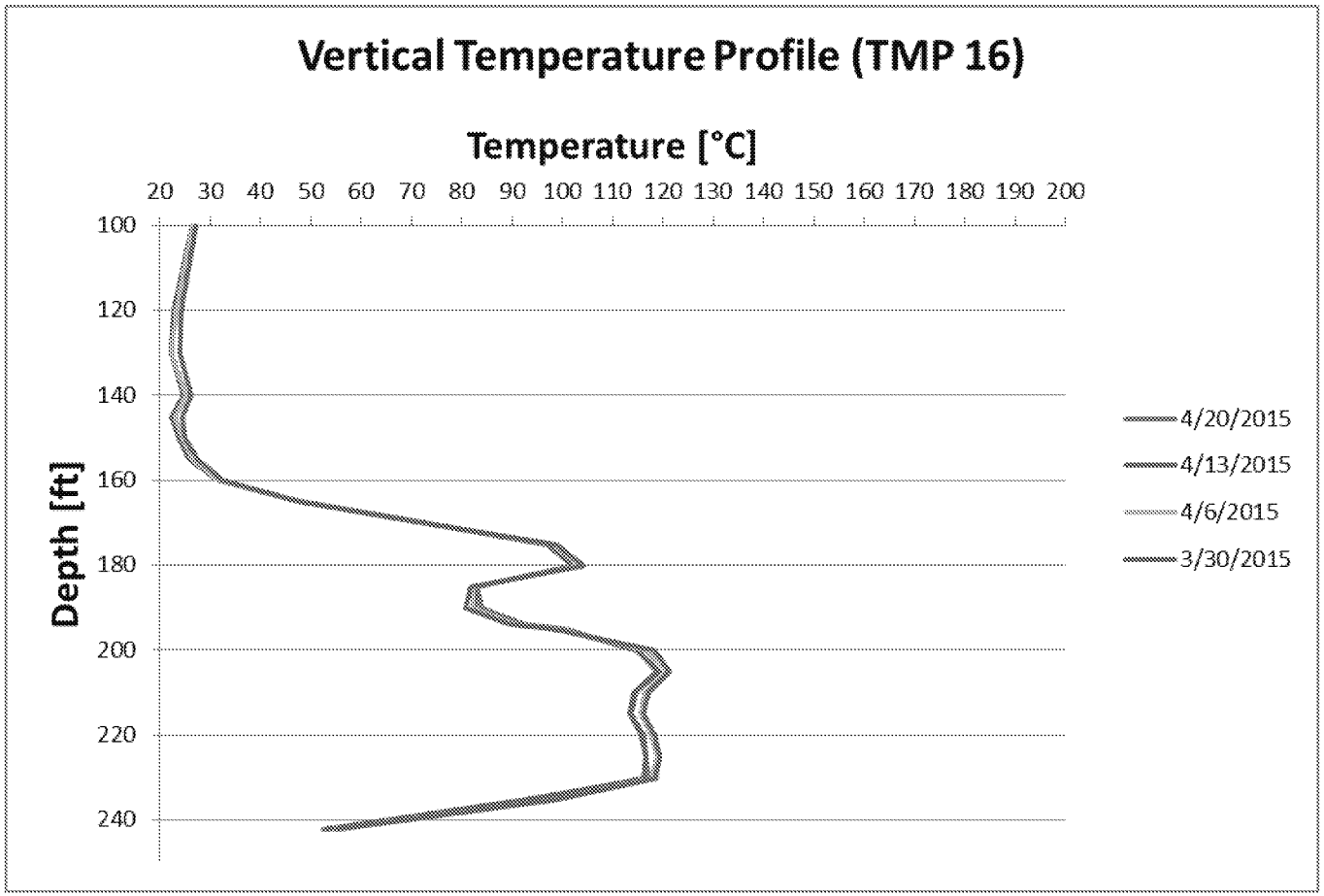

Vertical Temperature Profile (TMP 10)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100
120
140
160
180
200
220
240
4/20/2015
4/13/2015
4/6/2015
3/30/2015





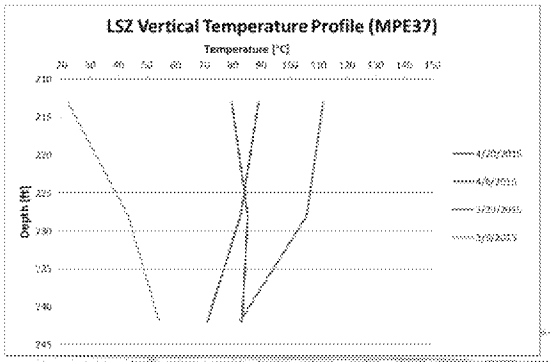


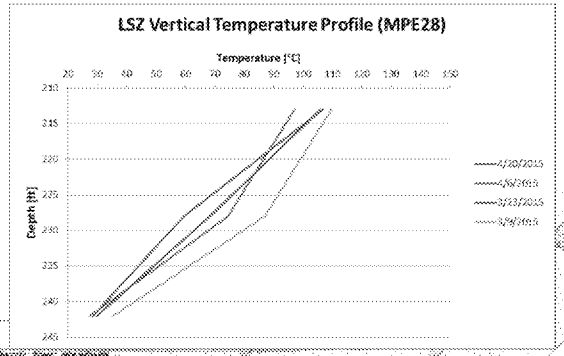

Vertical Temperature Profile (TMP 15)
Temperature [°C]
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Depth [ft]
100 120 140 160 180 200 220 240
4/20/2015
4/13/2015
4/6/2015
3/30/2015

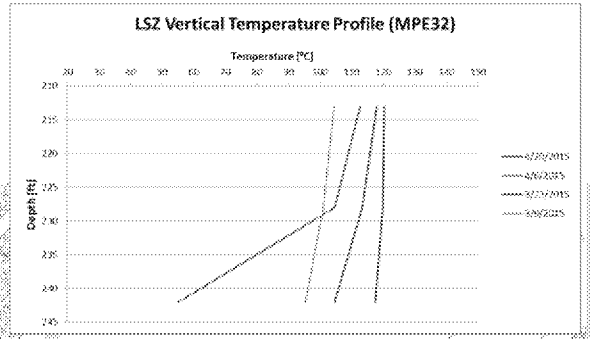


Subsurface Heat up Progression Measured at Collocated Extraction Well Thermocouples

ST012 SEE CO-LOCATED TEMPERATURES AT LSZ EXTRACTION WELLS: 2/2-3/16







LSZ MPE 28

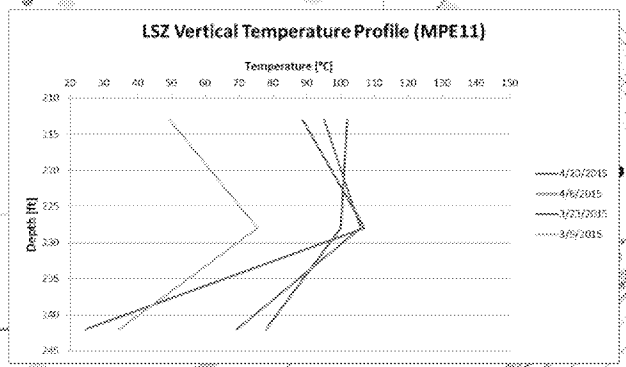
LSZ SIW 18

LSZ MPE 29

LSZ MPE 37

LSZ MPE 32

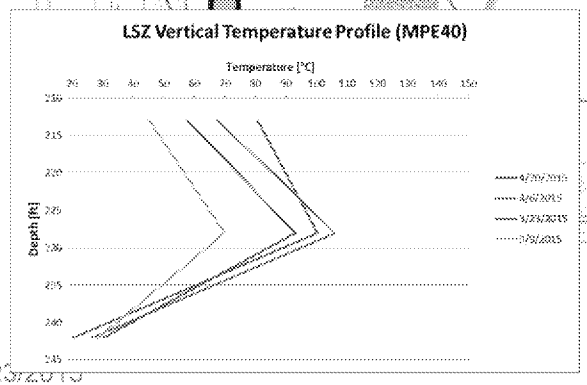
LSZ SIW 19

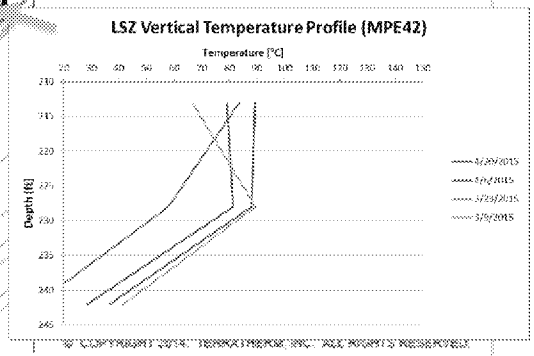


LSZ SIW 21

LSZ MPE 40

LSZ MPE 42

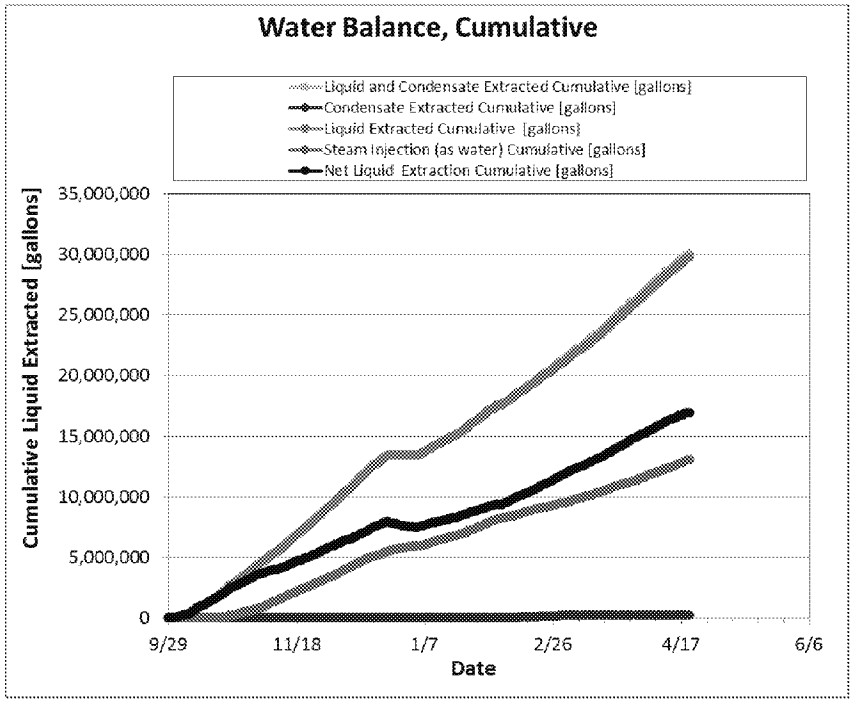


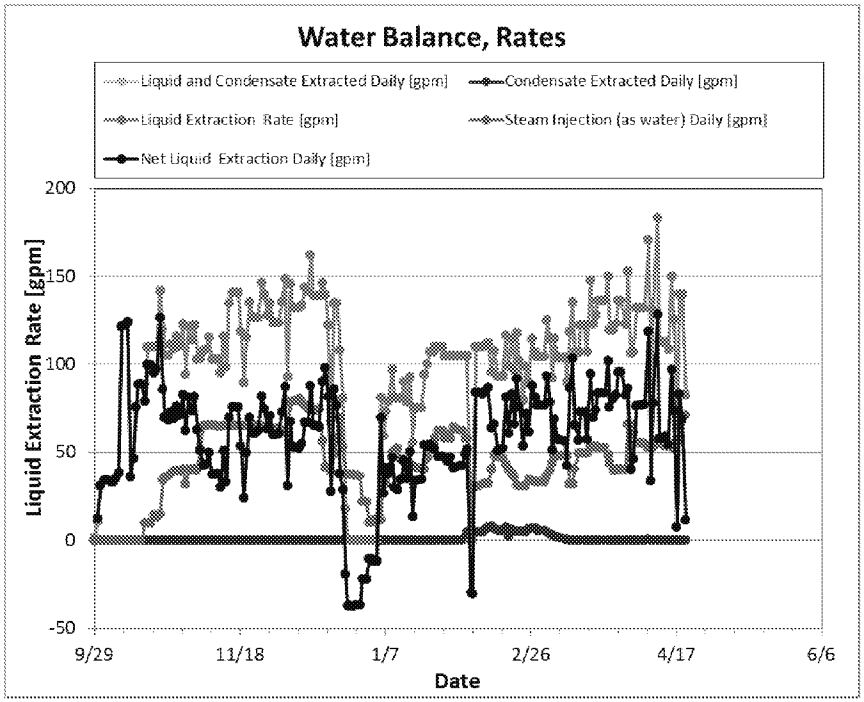


LSZ MPE 11

ST012 Injection/Extraction Balance Status

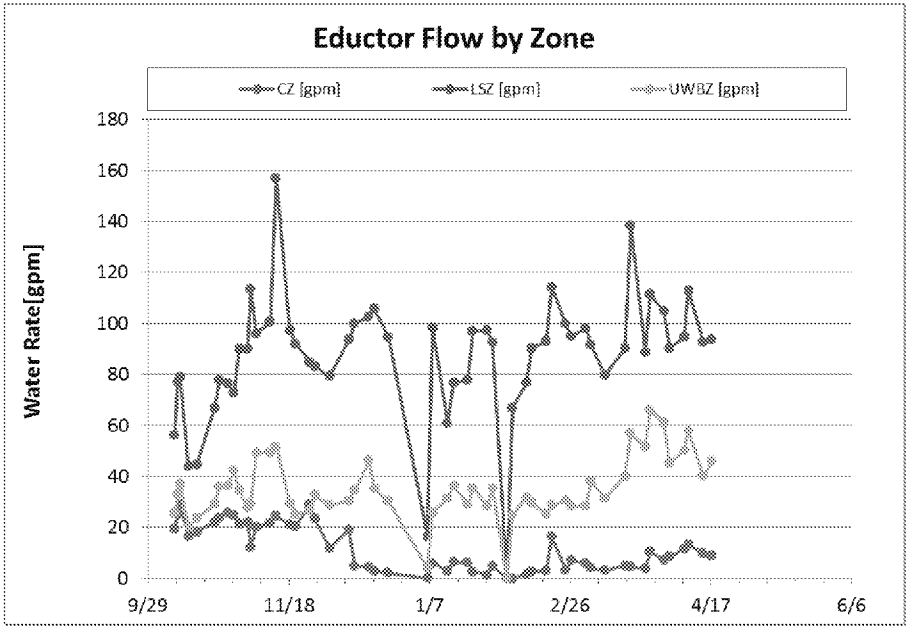
ST012 SEE SYSTEM WATER BALANCE

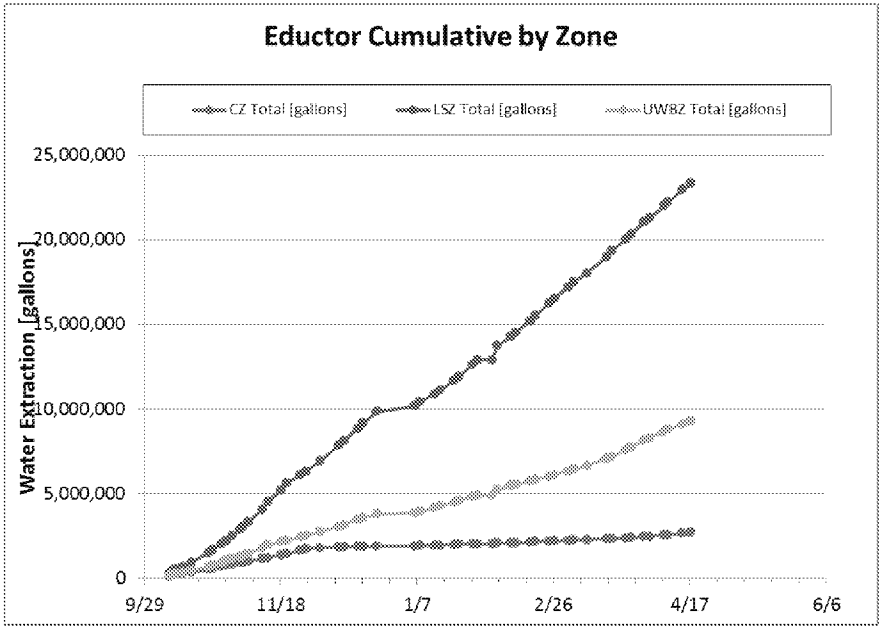




- **Condensate production began on 4 February indicating steam breakthrough at the first extraction well (LSZ6)**
- **Currently, the condensate production rate is ~0.1 gpm**

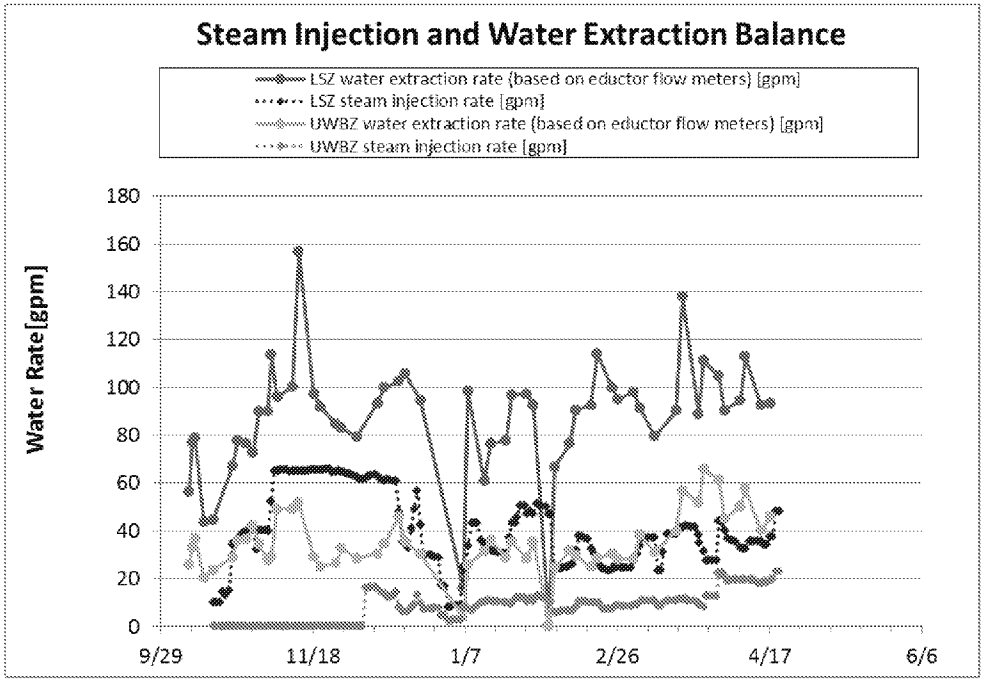
ST012 SEE SYSTEM WATER EXTRACTION BY ZONE





- **Eductor extraction rates per zone are based on individual eductor feed and return meters**

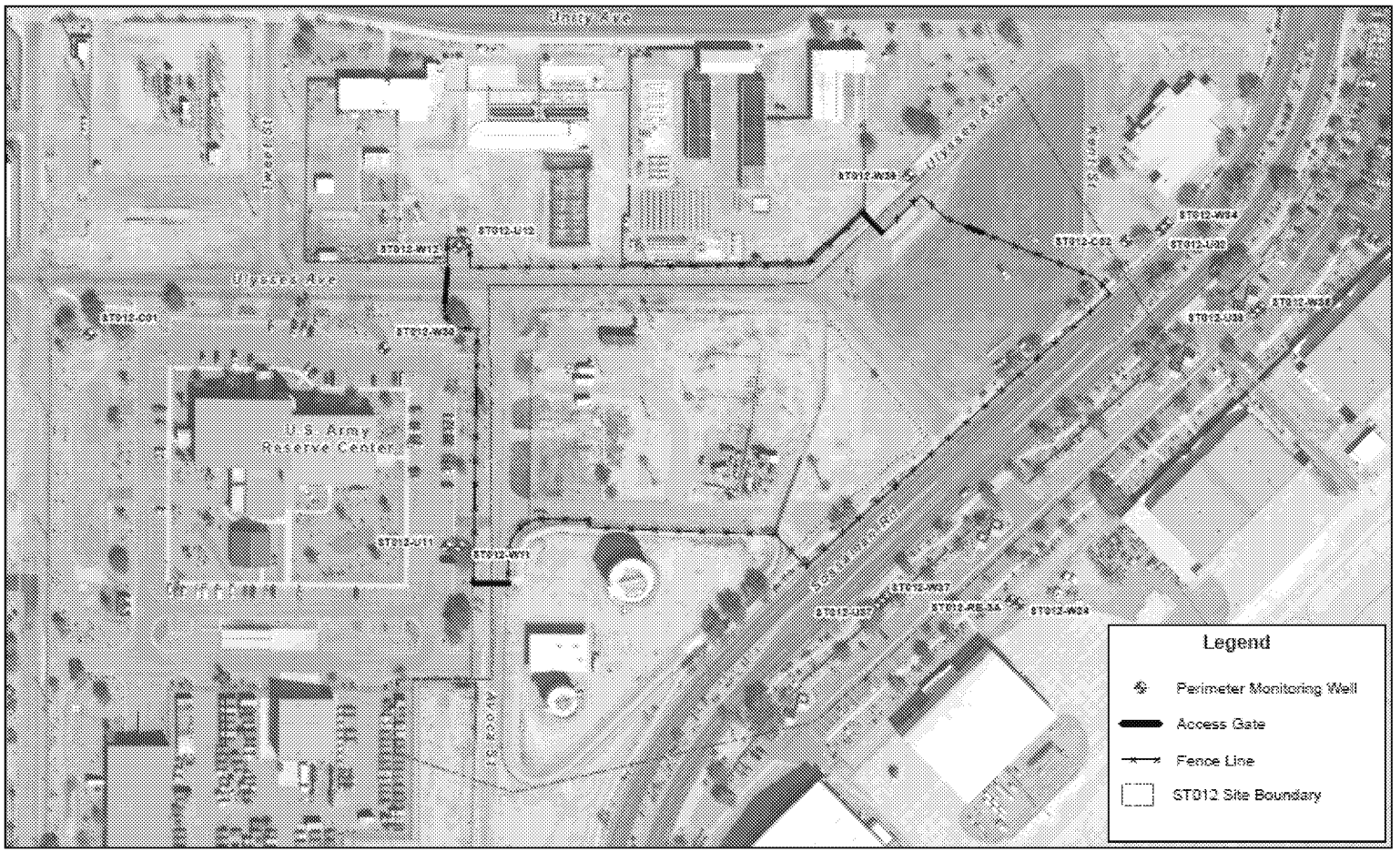
ST012 SEE SYSTEM INJECTION/EXTRACTION BALANCE



	CZ [gallons]	UWBZ [gallons]	LSZ [gallons]
Water extracted	2,711,000	9,298,000	23,342,000
Water injected (as steam)	0	2,233,000	10,874,000
Net extraction	2,711,000	7,065,000	12,468,000

- **Note: water extracted to date per zone is based on individual eductor meters**

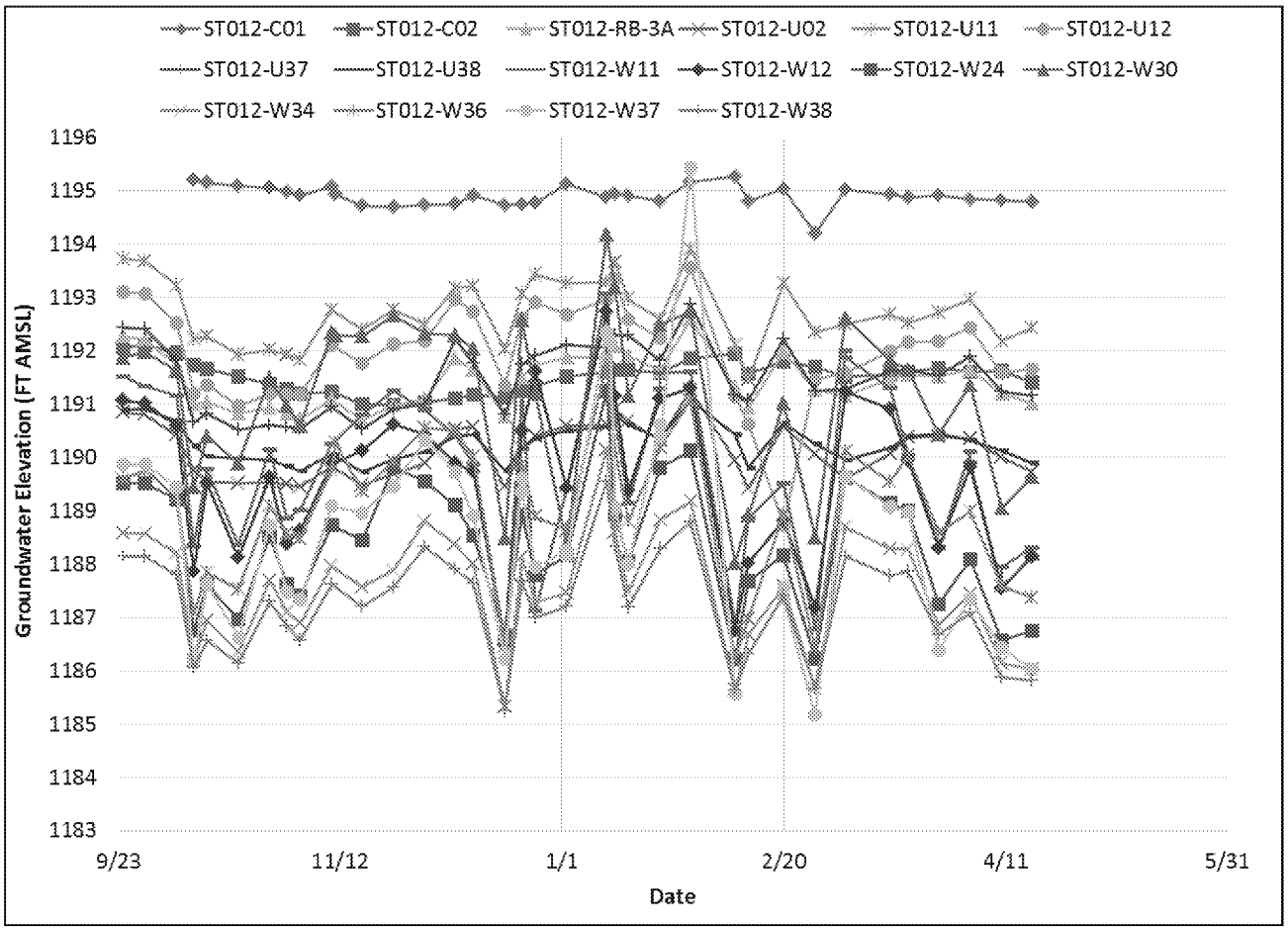
ST012 SEE PERIMETER GROUNDWATER MONITORING WELLS



ST012 SEE PERIMETER GROUNDWATER LEVEL DATA

Monitoring Well	4/3/2015		4/10/2015		4/17/2015	
	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous	Change from Baseline	Change from Previous
CZ/UWBZ Wells						
ST012-C01	-0.41	-0.04	-0.43	0.01	-0.48	-0.02
ST012-C02	-0.44	-0.05	-0.42	0.05	-0.64	-0.19
UWBZ Wells						
ST012-RB-3A	-0.61	0.17	-1.07	-0.43	-1.25	-0.15
ST012-U02	-0.48	-0.01	-0.83	-0.32	-1.10	-0.24
ST012-U11	-0.76	0.28	-1.55	-0.76	-1.30	0.28
ST012-U12	-0.67	0.28	-1.52	-0.82	-1.44	0.11
ST012-U37	-0.54	0.39	-1.20	-0.63	-1.28	-0.05
ST012-U38	-0.57	-0.10	-0.76	-0.16	-0.99	-0.20
LSZ Wells						
ST012-W11	-3.25	-0.02	-1.63	-0.19	-3.60	0.41
ST012-W12	-1.25	1.54	-3.51	-2.23	-2.92	0.62
ST012-W24	-1.42	0.88	-2.95	-1.50	-2.77	0.21
ST012-W30	-0.53	0.95	-2.83	-2.27	-2.24	0.62
ST012-W34	-1.13	0.62	-2.43	-1.27	-2.55	-0.09
ST012-W36	-0.63	0.42	-2.01	-1.35	-2.23	-0.19
ST012-W37	-2.50	0.99	-3.43	-0.89	-3.82	-0.36
ST012-W38	-1.05	0.44	-2.27	-1.19	-2.33	-0.03

ST012 SEE PERIMETER GROUNDWATER ELEVATIONS



- **Water level increases are temporary**

ST012 SEE OPERATIONAL CHALLENGES

- Iron Fouling
- Bio Fouling
- Perimeter Water Levels
- Temperature Monitoring Point Thermocouple Repair/Maintenance
- Boiler Maintenance
- Heat Response at TMP10
- Product at ST012-W37 and ST012-W11

ST012 SEE PERIMETER LNAPL THICKNESSES (FT)

Monitoring Well	4/3/2015		4/10/2015		4/17/2015	
CZ/UWBZ Wells	Before bailing	After Bailing	Before bailing	After Bailing	Before bailing	After Bailing
ST012-C01	0.00	0.00	0.00	0.00	0.00	0.00
ST012-C02	0.00	0.00	0.00	0.00	0.00	0.00
UWBZ Wells						
ST012-U02	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U11	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U12	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U37	0.00	0.00	0.00	0.00	0.00	0.00
ST012-U38	0.00	0.00	0.00	0.00	0.00	0.00
ST012-RB-3A	0.00	0.00	0.00	0.00	0.00	0.00
LSZ Wells						
ST012-W11	8.99	0.19	1.75	0.14	1.19	0.14
ST012-W12	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W24	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W30	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W34	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W36	0.00	0.00	0.00	0.00	0.00	0.00
ST012-W37	15.54	4.40	11.02	11.02	8.61	2.35
ST012-W38	0.00	0.00	0.00	0.00	0.00	0.00

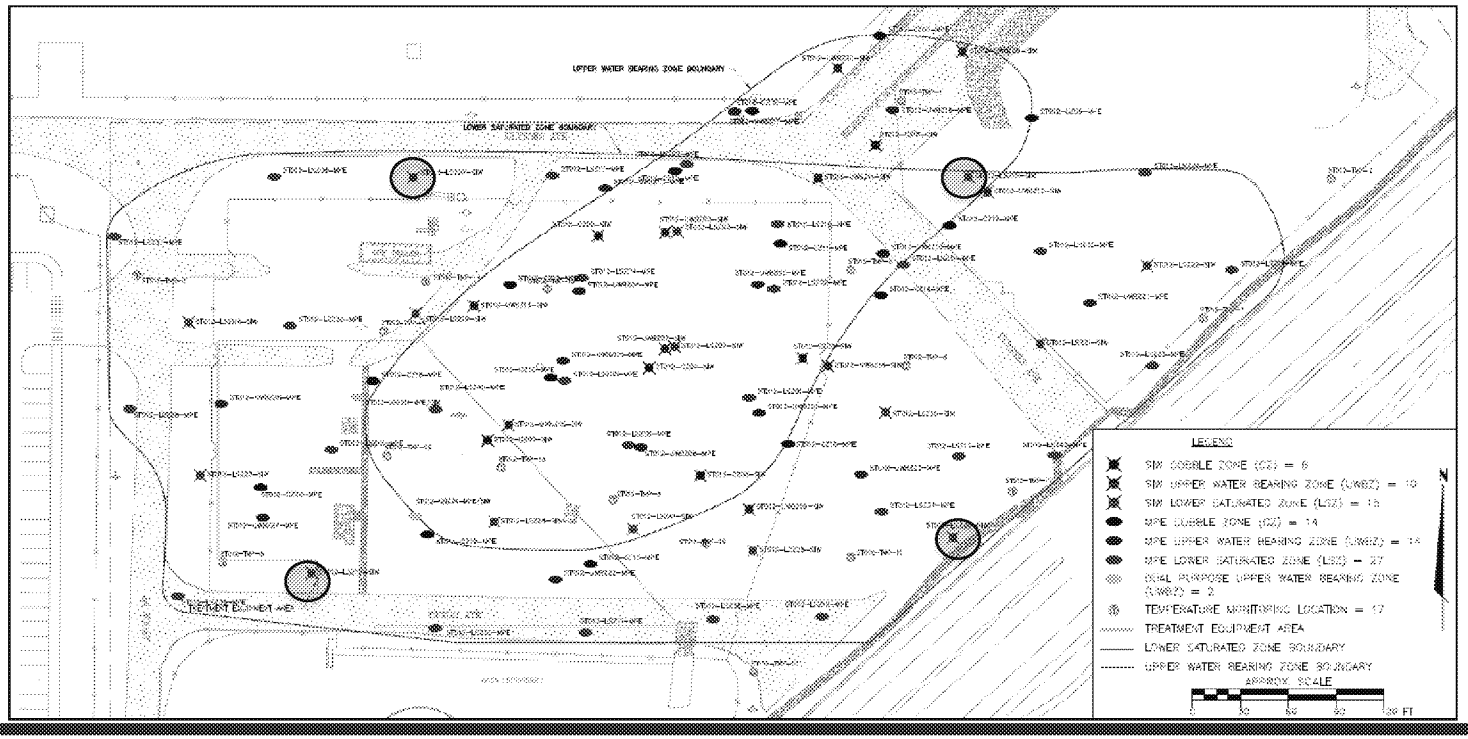
Perimeter Steam Injection – SEE Implementation Site ST012

BACKGROUND

- Steam injection was reduced at ST012-LSZ26 on February 6, 2015 out of an abundance of caution in response to temperature readings observed at ST012-TMP10. Due to eductor maintenance, the steam injection at LSZ26 was discontinued February 15 through March 16, 2015. After March 16, 2015 steam has been injected at LSZ26 at a reduced rate.
- At this time, eductor repairs have been implemented and treatment system bio fouling is under control such that the extraction system is operating as intended.
- To maximize mass removal we will be increasing steam injection rates in ST012-LSZ26 and continuing higher injection rates at other steam injection wells near the TTZ perimeter.
- As a result of these injections, some temperature increases are anticipated at perimeter TMPs and potentially at perimeter monitoring wells.
- These temperature increases are expected as explained on the following slides and should not be interpreted as a loss of containment.
- The ability to inject steam beyond the TTZ and recapture it in the MPE wells is an important component to achieve NAPL removal where present at and beyond the TTZ perimeter

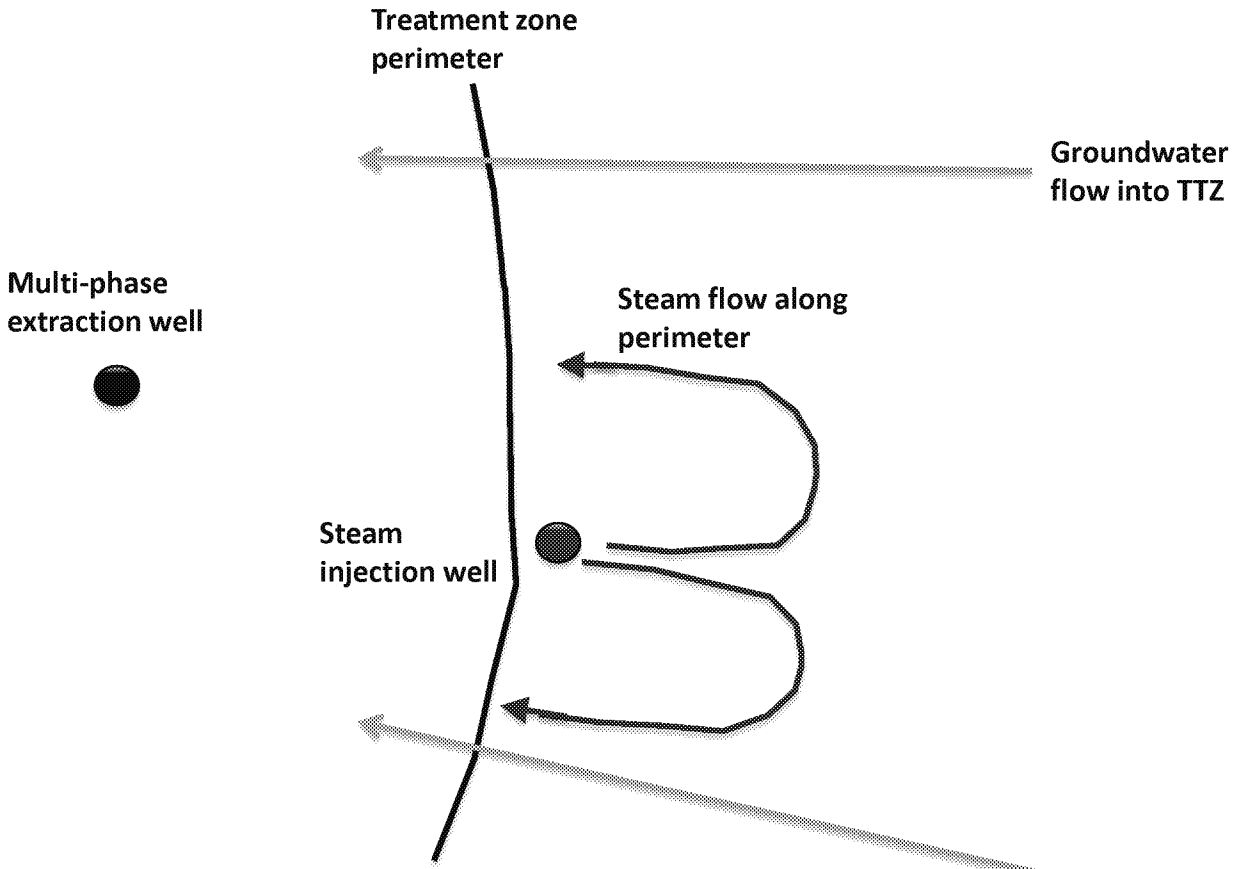
SEE DESIGN BASIS

- The SEE design included steam injection wells located along the perimeter (see figure below).
- Once injected, steam will follow the most permeable route available. Because of this, a certain amount of steam migration is anticipated outside the treatment zone footprint.
- The numerical modeling performed for the site assumed the steam front would extend an average of approximately 33 ft (10 m) outside the treatment zone perimeter. Thermal conduction heating will then extend the heated zone further outside of the treatment zone perimeter.
- Perimeter steam wells (highlighted):



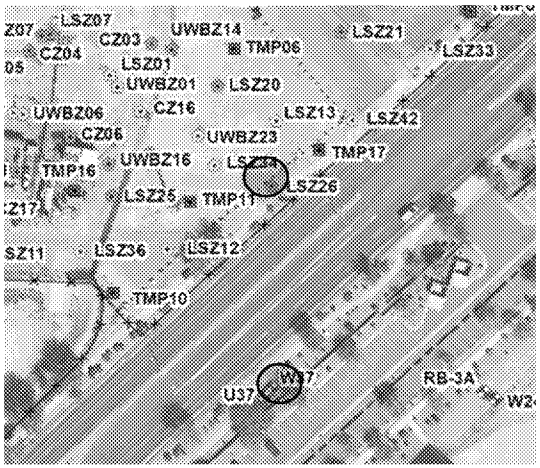
STEAM MIGRATION ALONG SITE PERIMETER – A CLOSER LOOK

- During steam injection periods, steam will migrate outside of the treatment zone along the site perimeter. An inward hydraulic gradient is maintained at the site and will capture the steam as condensed water and draw it back into the treatment zone.



SITE ST012 EXAMPLE: STEAM INJECTION AT LSZ26

- LSZ26 began injecting steam on 10/16/14. Steam has been injected at an average rate of 1,250 lbs/hr (for 172 days), for a total steam injection of 5.2 million lbs or 620,000 gallons of water to date (4/8/15).



- The four MPE wells surrounding LSZ26 have extracted a total of approximately 3,350,000 gallons of water since the start of operations.

- As shown by the perimeter groundwater levels, we have established a drawdown at W37 greater than 1 ft for the majority of SEE operations (with the exception of a few periods during steam bubble build up). However, even with this significant net drawdown, we may see a limited temperature increase at W37 due to heat transport and thermal conduction heating.

ST012 SEE OPERATIONAL PLAN

Operational Plan through May

- **Achieve steam breakthrough in the UWBZ and LSZ**
  - Fifteen LSZ steam wells are operating
  - Ten UWBZ steam wells are operating
  - Total system is operating at approximately 130 gpm liquid extraction and up to 86 gpm steam injection (43,000 lbs/hr)
  - Balance flows to maintain an acceptable water balance
  - Increase and optimize injection and extraction rates
- **Bring CZ and two dual-purpose wells online**
  - Keep current 25 steam injection wells online
  - Reduce injection and start steam cycling when data support this change
  - Bring CZ wells online
  - Bring two dual-purpose UWBZ wells online when data support this change
  - Injection rates will continue to be balanced across the wellfield to maintain an acceptable water balance